NASA Facts

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

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Robert H. Goddard: American Rocket Pioneer

The father of modern rocket propulsion is the American, Dr. Robert Hutchings Goddard. Along with Konstantin Eduordovich Tsiolkovsky of Russia and Hermann Oberth of Germany, Goddard envisioned the exploration of space. A physicist of great insight, Goddard also had an unique genius for invention.

By 1926, Goddard had constructed and tested successfully the first rocket using liquid fuel. Indeed, the flight of Goddard's rocket on March 16, 1926, at Auburn, Massachusetts, was a feat as epochal in history as that of the Wright brothers at Kitty Hawk. Yet, it was one of Goddard's "firsts" in the now booming significance of rocket propulsion in the fields of military missilery and the scientific exploration of space.

Primitive in their day as the achievement of the Wrights, Goddard's rockets made little impression upon government officials. Only through the modest subsidies of the Smithsonian Institution and the Daniel Guggenheim Foundation, as well as the leaves of absence granted him by Worcester Polytechnic Institute of Clark University , was Goddard able to sustain his lifetime of devoted research and testing. He worked for the U.S. Navy in both World Wars. Eighteen years after his successful demonstration at Auburn, Goddard's pioneering achievements came to life in the German V-2 ballistic missile.

Goddard first obtained public notice in 1907 in a cloud of smoke from a powder rocket fired in the basement of the physics building in Worcester Polytechnic Institute. School officials took an immediate interest in the work of student Goddard. They, to their credit, did not expel him. He thus began his lifetime of dedicated work.

In 1914, Goddard received two U.S. patents. One was for a rocket using liquid fuel. The other was for a two or three stage rocket using solid fuel. At his own expense, he began to make systematic studies about propulsion provided by various types of gunpowder. His classic document was a study that he wrote in 1916 requesting funds of the Smithsonian Institution so that he could continue his research. This was later published along with his subsequent research and Navy work in a Smithsonian Miscellaneous Publication No. 2540 (January 1920). It was entitled "A Method of Reaching Extreme Altitudes." In this treatise, he detailed his search for methods of raising weather recording instruments higher than sounding balloons. In this search, as he related, he developed the mathematical theories of rocket propulsion.

Dr. Robert H. Goddard, Rocket Pioneer for whom the Goddard Space Flight Center is named. *Photo courtesy of Mrs. Robert H. Goddard.*

BIOGRAPHICAL DATA

Born:	Worcester, Massachusetts, October 5, 1882
Died:	August 10, 1945
Education:	B.S. Degree, Worcester Polytechnic Institute, 1908; M.A. Clark University, 1910; Ph.D. Clark University, 1911
Academic Career:	Instructor of Physics, Worcester Polytechnic Institute, 1910-1911; student at Princeton University, 1914-1915; Assistant Professor, 1915-1919; full Professor at Clark after 1919.

Towards the end of his 1920 report, Goddard outlined the possibility of a rocket reaching the moon and exploding a load of flash powder there to mark its arrival. The bulk of his scientific report to the Smithsonian was a dry explanation of how he used the $5000 grant in his research. Yet, the press picked up Goddard's scientific proposal about a rocket flight to the moon and erected a journalistic controversy concerning the feasibility of such a thing. Much ridicule came Goddard's way. And he reached firm convictions about the virtues of the press corps which he held for the rest of his life. Yet, several score of the 1750 copies of the 1920 Smithsonian report reached Europe. The German Rocket Society was formed in 1927, and the German Army began its rocket program in 1931.

Goddard's greatest engineering contributions were made during his work in the 1920's and 1930's (see list of historic firsts). He received a total of $10,000 from the Smithsonian by 1927, and through the personal efforts of Charles A. Lindbergh, he subsequently received financial support from the Daniel and Florence Guggenheim Foundation. Progress on all of his work was published in "Liquid Propellant Rocket Development," which was published by the Smithsonian in 1936.

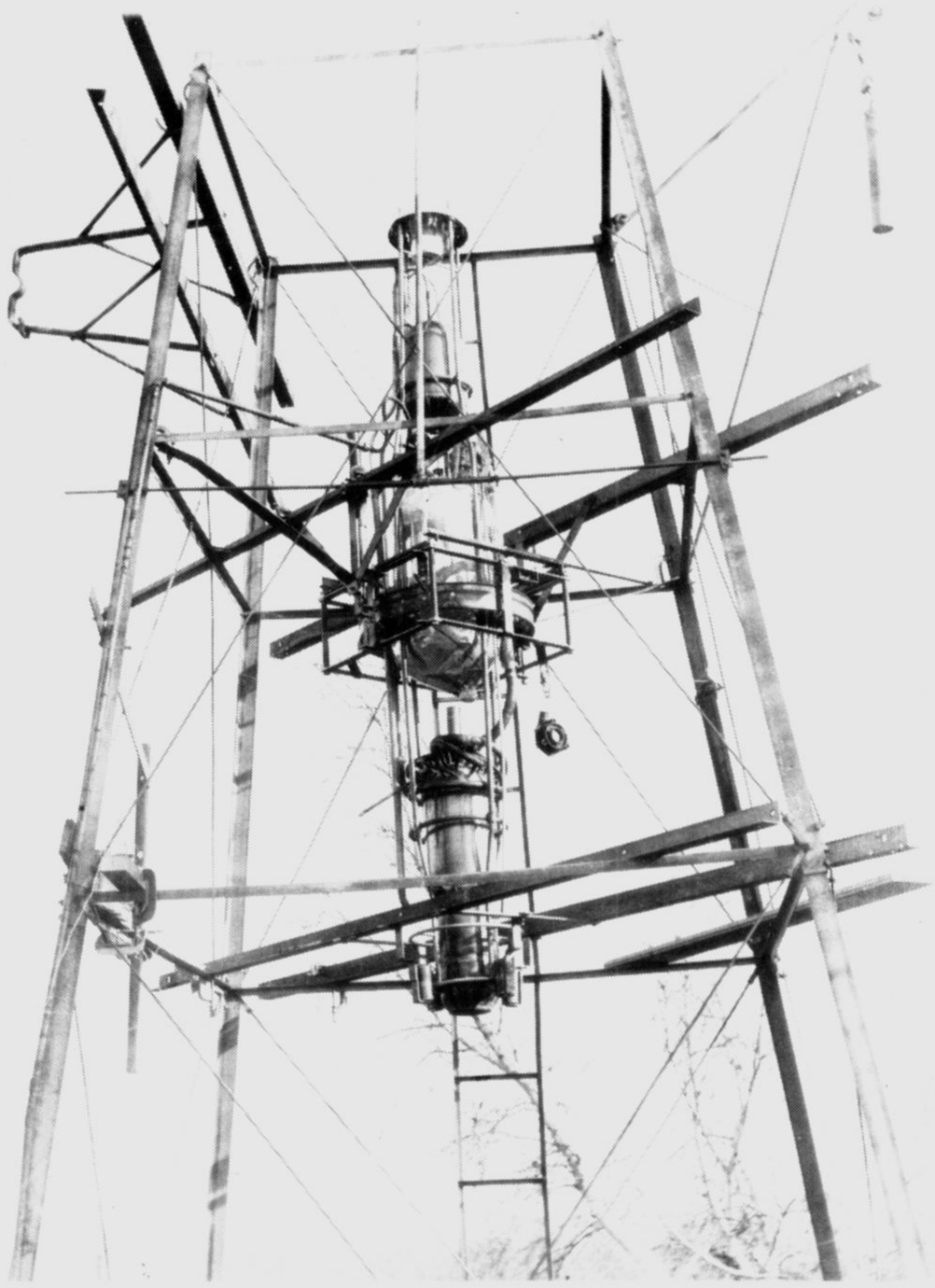
Goddard's work largely anticipated in technical detail the later German V-2 missiles, including gyroscopic control, steering by means of vanes in the jet stream of the rocket motor, gimbal-steering, power-driven fuel pumps and other devices. His rocket flight in 1929 carried the first scientific payload, a barometer, and a camera. Goddard developed and demonstrated the basic idea of the "bazooka" two days before the Armistice in 1918 at the Aberdeen Proving Ground. His launching platform was a music rack. Dr. Clarence N. Hickman, a young Ph.D. from Clark University, worked with Goddard in 1918 and provided continuity to the research that produced the World War II bazooka. In World War II, Goddard again offered his services and was assigned by the U.S. Navy to the development of practical jet assisted takeoff (JATO) and liquid propellant rocket motors capable of variable thrust. In both areas, he was successful. He died on August 10, 1945, four days after the first atomic bomb was dropped on Japan.

Goddard was the first scientist who not only realized the potentialities of missiles and space flight but also contributed directly in bringing them to practical realization. This rare talent in both creative science and practical engineering places Goddard well above the opposite numbers among the European rocket pioneers. The dedicated labors of this modest man went largely unrecognized in the United States until the dawn of what is now called the "space age." High honors and wide acclaim, belated but richly deserved, now come to the name of Robert H. Goddard.

On September 16, 1959, the 86th Congress authorized the issuance of a gold medal in the honor of Professor Robert H. Goddard.

In memory of the brilliant scientist, a major space science laboratory, NASA's Goddard Space Flight Center, Greenbelt, Maryland, was established on May 1, 1959.

Dr. Robert H. Goddard with his rocket in his workshop at Roswell, New Mexico, October 1935. *Photo courtesy of Mrs. Robert H. Goddard.*

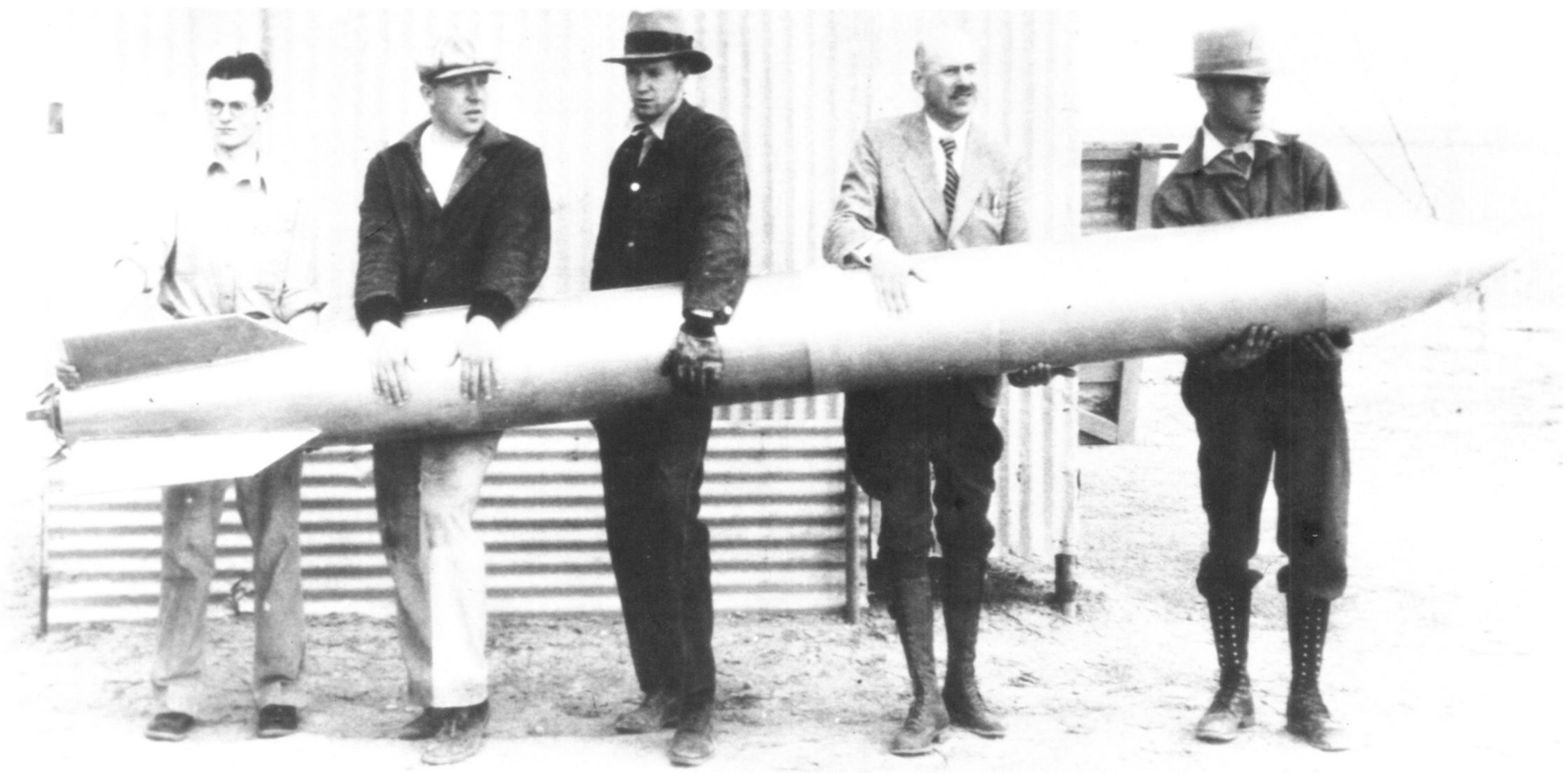


Setup for Dr. Goddard's test of April 20, 1927, with parachute attachment and turntable for launching, at Auburn, Massachusetts. *Photo courtesy of Mrs. Robert H. Goddard.*

GODDARD'S HISTORIC FIRSTS

Robert H. Goddard's basic contribution to missilery and space flight is a lengthy list. As such, it is an eloquent testimonial to his lifetime of work in establishing and demonstrating the fundamental principles of rocket propulsion.

- First explored mathematically the practicality of using rocket propulsion to reach high altitudes and even the moon (1912);
- First proved, by actual static test, that a rocket will work in a vacuum, that it needs no air to push against;
- First developed and shot a liquid fuel rocket, March 16, 1926;
- First shot a scientific payload (barometer and camera) in a rocket flight (1929, Auburn, Massachusetts);
- First used vanes in the rocket motor blast for guidance (1932, New Mexico);
- First developed gyro control apparatus for rocket flight (1932, New Mexico);
- First received U.S. patent in idea of multi-stage rocket (1914);
- First developed pumps suitable for rocket fuels;
- First launched successfully a rocket with a motor pivoted on gimbals under the influence of a gyro mechanism (1937).



Dr. Goddard and colleagues holding the rocket used in the flight of April 19, 1932. They are, from left to right, L. Mansur, A. Kisk, C. Mansur, Dr. R. H. Goddard, and Nils Ljungquist. *Photo courtesy of Mrs. Robert H. Goddard.*

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NASA HEADQUARTERS
Washington, D.C. 20546

NASA Headquarters formulates policy, coordinates the activities, and controls the NASA programs of the space flight centers, research centers, and other installations which comprise the National Aeronautics and Space Administration.

AMES RESEARCH CENTER
Moffett Field, California 94035

Ames Research Center conducts laboratory and flight research in space missions and in aeronautics. The fields of space interest include atmosphere entry research, planetary atmospheres (Mars and Venus) and into the Earth's atmosphere at the velocities of return trips from interplanetary flight, fundamental physics, materials, guidance and control, chemistry and life sciences. Ames aeronautical research includes the areas of supersonic flight, V/STOL aircraft and operational problems.

As lead Center for Helicopter research, Ames provides overall direction to the program and conducts research in aeromechanics, which includes technology integration and large-scale testing and simulation. Ames' space flight projects include management of scientific probes and satellites, and payloads for flight experiments. Project Pioneer is managed by Ames.

ARC DRYDEN FLIGHT RESEARCH FACILITY
Edwards, California 93523

The Dryden Flight Research Facility is concerned with manned flight within and outside the atmosphere, including low-speed, supersonic, hypersonic and reentry flight, general aviation and extremely high performance aircraft and spacecraft, such as the F-15. Space vehicle programs are typified by studies such as flight behavior of lifting bodies and flight systems, structural characteristics of aeronautical and space vehicles. In biotechnology, man-machine integration problems are studied.

Some of the research aircraft previously tested at DFRF include the X-1, D-558, X-3, X-4, X-5, XB-70, and the X-15, which was piloted to world speed and altitude records of 4500 mph and 350,000 feet. The Approach and Landing Tests (ALT), designed to verify the aerodynamics and landing abilities of the Space Shuttle Orbiter were conducted at DFRF. The first several Orbiter landings, following Earth orbital flights, also were made at Dryden.

GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland 20771

The Goddard Space Flight Center, named for the rocket pioneer, Dr. Robert H. Goddard, is responsible for the development and management of a broad variety of unmanned Earth-orbiting satellite and sounding rockets experiments. Among its major projects are Orbiting Observatories, Explorers, Tiros 4, Nimbus, and LANDSAT (formerly Earth Resources Technology) Satellites. Goddard is also the nerve center for the worldwide tracking and communications network for both manned and unmanned satellites.

The hub of the spaceflight Tracking and Data Network (STDN) and the NASA Communications Network (NASCOM), for the Space Shuttle, are located at Goddard. Goddard is also responsible for scientific instrumentation, mission operations, and data reduction of the Space Telescope.

JET PROPULSION LABORATORY
Pasadena, California 91103

The Jet Propulsion Laboratory is a research, development, and flight center operated for the National Aeronautics and Space Administration by the California Institute of Technology. The Laboratory's primary role is the investigation of the planets using automated scientific spacecraft. Jet Propulsion Laboratory is also responsible to NASA for supporting research and advanced development related to flight projects and the design and operation of the Deep Space Network, which tracks, communicates with, and commands spacecraft on lunar, interplanetary, and planetary missions, including the Viking-Mars, Mariner, Voyager, Galileo, and Venus Orbiting Imaging Radar (VOIR) Projects.

JOHN F. KENNEDY SPACE CENTER
Florida 32899

The Nation's first spaceport, the John F. Kennedy Space Center, makes preflight tests, prepares, and launches manned and unmanned space vehicles for NASA. Manned Apollo and Skylab missions, and the Apollo Soyuz Test Project (ASTP), were launched by the Kennedy Space Center. In addition, unmanned planetary, and interplanetary missions, and scientific meteorological, and communications satellites are launched by KSC. Some launches are from the Pacific Coast; these are conducted by the KSC Western Test Range Operations Division at Lompoc, California. The Space Shuttle will take off from a KSC launch pad much like conventional spacecraft, but land on a runway at Kennedy Space Center much like a jetliner.

LANGLEY RESEARCH CENTER
Hampton, Virginia 23365

Oldest of the NASA Centers, Langley has the task of providing technology for manned and unmanned exploration of space and for improvement and extension of performance, utility and safety of aircraft. The major technical areas of Langley are theoretical and experimental dynamics of flight through the entire speed range, flight mechanics, materials and structures, space mechanics, instrumentation, solid rocket technology, and advanced hypersonic engine research. The Center conceives, develops and operates simulators for aircraft and spacecraft, and conducts V/STOL flight research in structures and materials, avionics and noise.

The Center is charged with overall project management for Viking. The Long-Duration Exposure Facility (LDEF) is a product of the Langley Research Center.

LEWIS RESEARCH CENTER
Cleveland, Ohio 44135

The major missions of Lewis are aircraft and rocket propulsion and space power generation. Other fields of investigation include materials and metallurgy, and the problems in the use of extremely high and low temperature materials. The Center is active in combustion and direct energy conversion; chemical, nuclear and electric rocket propulsion systems; advanced turbojet power plants; fuels and lubricants; plasmas and magnetohydrodynamics; aircraft noise reduction; engine pollution reduction; and maintains a data bank of research information in aerospace safety. Lewis has technical management of such rocket stages as the Atlas-Agena, Atlas-Centaur, and Thor-Agena.

LYNDON B. JOHNSON SPACE CENTER
Houston, Texas 77058

The Johnson Space Center manages the Space Shuttle Program, and is also responsible for development, production, and delivery of the Orbiters; testing of manned spacecraft-associated systems; development and integration of experiments for space flight activities; application of space technology, and supporting scientific engineering, and medical research; the selection and training of astronauts; and operation of manned space flights. Mission Control for manned space flights is at the Johnson Space Center.

MARSHALL SPACE FLIGHT CENTER
Huntsville, Alabama 35812

The development, production, and delivery of the Solid Rocket Boosters, the External Tank, and the Orbiter main engines for the Shuttle are the responsibility of Marshall. Launch vehicles essential to Apollo and other major missions were designed and developed by the scientists and engineers of the George C. Marshall Space Flight Center. The Center is also concerned with payloads, related research and studies of advanced propulsion design; development and integration of payloads and experiments for assigned space flight activities. The Spacelab Program Office has responsibility for the technical and programmatic monitoring of Spacelab design and development activities in Europe. Marshall also has overall responsibility for management of the first three Spacelab missions, and project management for the Space Telescope.

WALLOPS FLIGHT CENTER
Wallops Island, Virginia 23337

Wallops Flight Center, located on Virginia's eastern shore, is one of the oldest and busiest ranges in the world. Some 300 experiments are sent aloft each year on vehicles which vary in size from small meteorological rockets to the four-stage Scout with orbital capability. The launches increase knowledge of the upper atmosphere and the space environment. A sizeable portion of Wallops' effort is devoted to aeronautical research and development and in exporting this Nation's space technology to the international community.

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